CHAPTER 3

PROJECTIONS AND VIEWS

When you have read and understood this chapter, you should be able to answer the following learning objectives:

- *Describe the types of projections.*
- *Describe the types of views.*

In learning to read blueprints you must develop the ability to visualize the object to be made from the blueprint (fig. 3-1). You cannot read a blueprint all at once any more than you can read an entire page of print all at once. When you look at a multiview drawing, first survey all of the views, then select one view at a time for more careful study. Look at adjacent views to determine what each line represents.

Each line in a view represents a change in the direction of a surface, but you must look at another view to determine what the change is. A circle on one view may mean either a hole or a protruding boss (surface) as shown in the top view in figure 3-2. When you look at the top view you see two circles, and you must study the other view to understand what each represents. A glance at the front view shows that the smaller circle represents a hole (shown in dashed lines), while the larger circle represents a protruding boss. In the same way, you must look at the top view to see the shape of the hole and the protruding boss.

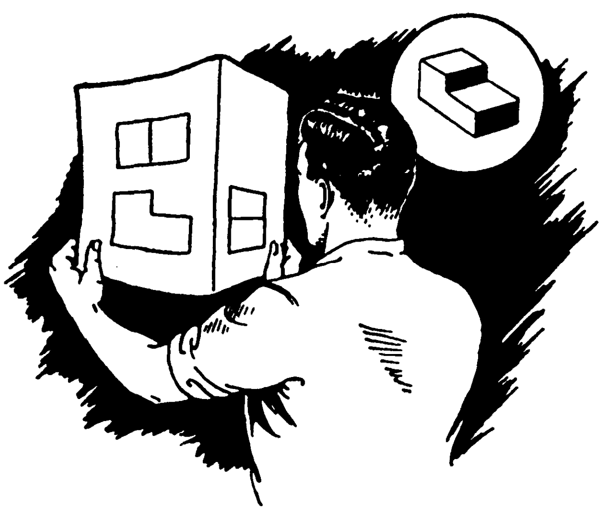

Figure 3-1.—Visualizing a blueprint.

You can see from this example that you cannot read a blueprint by looking at a single view, if more than one view is shown. Sometimes two views may not be enough to describe an object; and when there are three views, you must view all three to be sure you read the shape correctly.

PROJECTIONS

In blueprint reading, a view of an object is known technically as a projection. Projection is done, in theory, by extending lines of sight called projectors from the eye of the observer through lines and points on the object to the plane of projection. This procedure will always result in the type of projection shown in

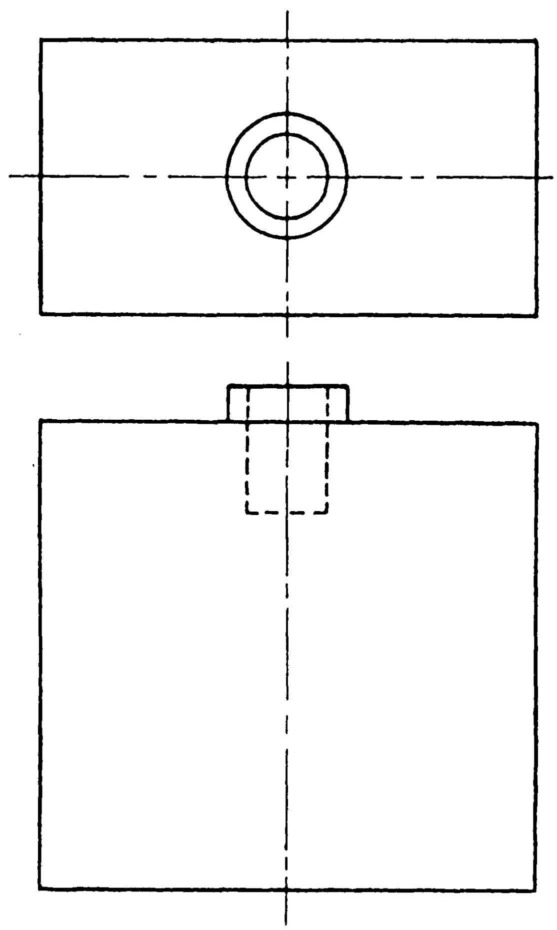

Figure 3-2.—Reading views.

fig. 3-3. It is called central projection because the lines of sight, or projectors, meet at a central point; the eye of the observer.

You can see that the projected view of the object varies considerably in size, according to the relative positions of the objects and the plane of projection. It will also vary with the distance between the observer and the object, and between the observer and the plane of projection. For these reasons, central projection is seldom used in technical drawings.

If the observer were located a distance away from the object and its plane of projection, the projectors would not meet at a point, but would be parallel to each other. For reasons of convenience, this parallel projection is assumed for most technical drawings and is shown in figure 3-4. You can see that, if the projectors are perpendicular to the plane of projection, a parallel projection of an object has the same dimensions as the object. This is true regardless of the relative positions of the object and the plane of projection, and regardless of the distance from the observer.

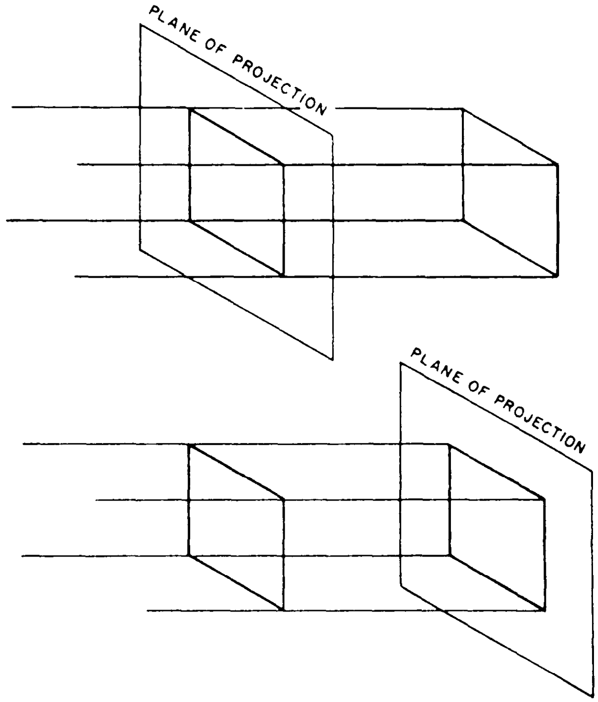

Figure 3-4.—Parallel projections.

ORTHOGRAPHIC AND OBLIQUE PROJECTION

An ORTHOGRAPHIC projection is a parallel projection in which the projectors are perpendicular to the plane of projection as in figure 3-4. An OBLIQUE projection is one in which the projectors are other than perpendicular to the plane of projection. Figure 3-5 shows the same object in both orthographic and oblique projections. The block is placed so that its

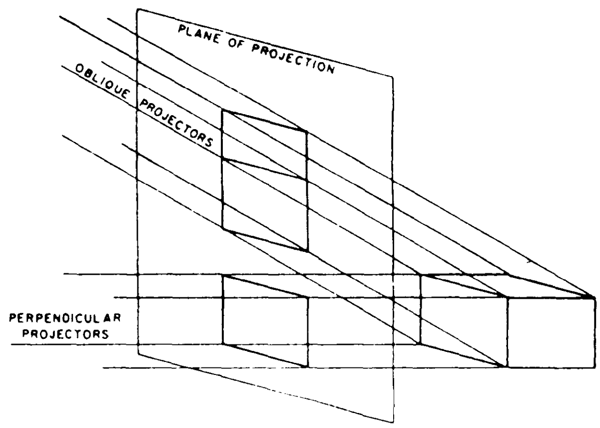

Figure 3-5.—Oblique and orthographic projections.

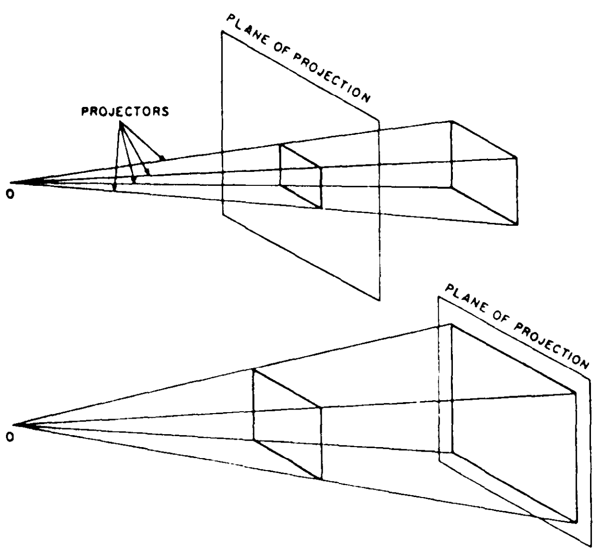

Figure 3-3.—Central projection.

front surface (the surface toward the plane of projection) is parallel to the plane of projection. You can see that the orthographic (perpendicular) projection shows only this surface of the block, which includes only two dimensions: length and width. The oblique projection, on the other hand, shows the front surface and the top surface, which includes three dimensions: length, width, and height. Therefore, an oblique projection is one way to show all three dimensions of an object in a single view. Axonometric projection is another and we will discuss it in the next paragraphs.

ISOMETRIC PROJECTION

Isometric projection is the most frequently used type of axonometric projection, which is a method used to show an object in all three dimensions in a single view. Axonometric projection is a form of orthographic projection in which the projectors are always perpendicular to the plane of projection. However, the object itself, rather than the projectors, are at an angle to the plane of projection.

Figure 3-6 shows a cube projected by isometric projection. The cube is angled so that all of its surfaces make the same angle with the plane of projection. As a result, the length of each of the edges shown in the projection is somewhat shorter than the actual length of the edge on the object itself. This reduction is called foreshortening. Since all of the surfaces make the angle with the plane of projection, the edges foreshorten in the same ratio. Therefore, one scale can be used for the entire layout; hence, the term *isometric* which literally means the same scale.

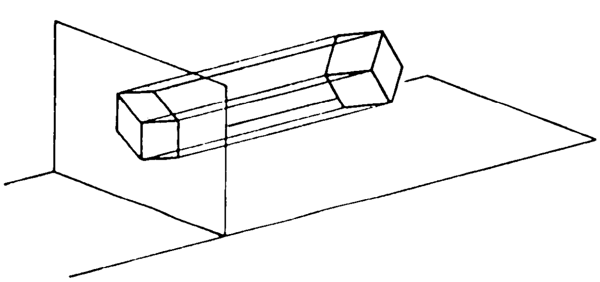

Figure 3-6.—Isometric projection.

VIEWS

The following pages will help you understand the types of views commonly used in blueprints.

MULTIVIEW DRAWINGS

The complexity of the shape of a drawing governs the number of views needed to project the drawing. Complex drawings normally have six views: both ends, front, top, rear, and bottom. However, most drawings are less complex and are shown in three views. We will explain both in the following paragraphs.

Figure 3-7 shows an object placed in a transparent box hinged at the edges. With the outlines scribed on each surface and the box opened and laid flat as shown in views A and C, the result is a six-view orthographic

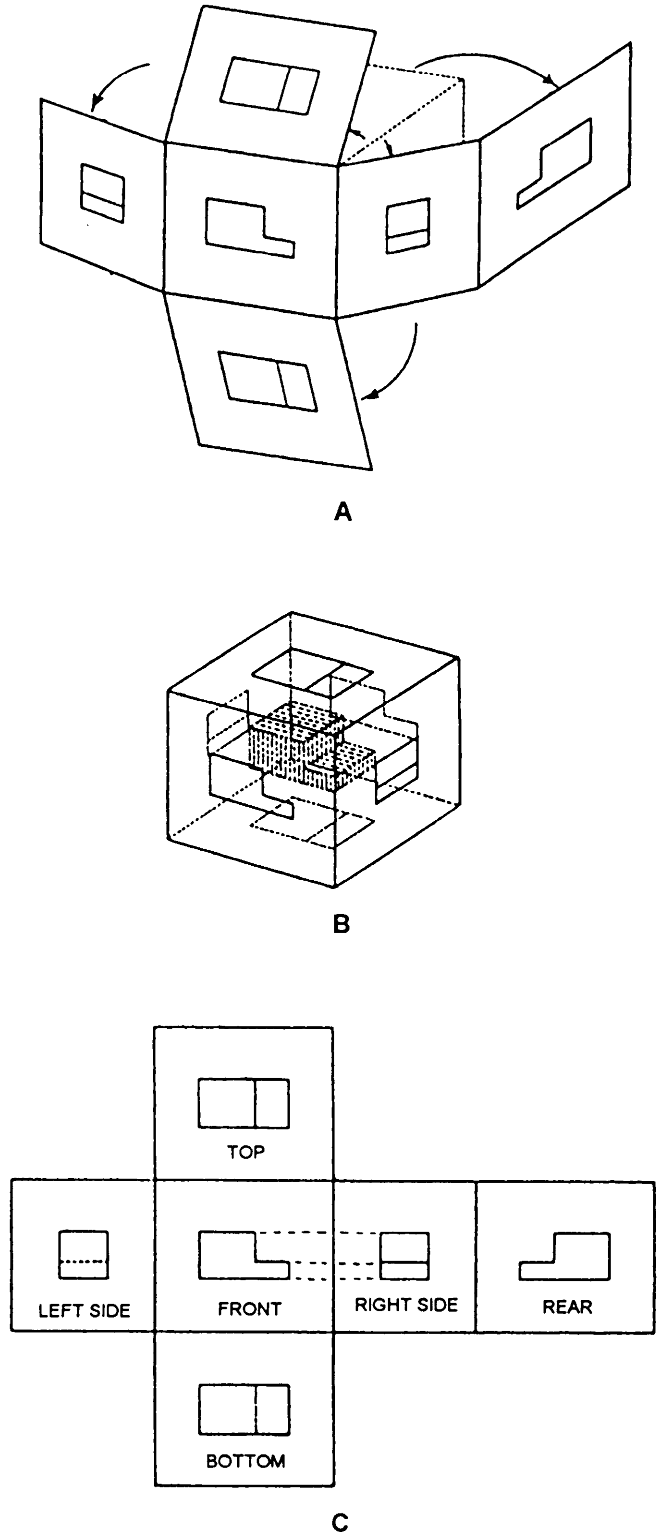

Figure 3-7.—Third-angle orthographic projection.

projection. The rear plane is hinged to the right side plane, but it could hinge to either of the side planes or to the top or bottom plane. View B shows that the projections on the sides of the box are the views you will see by looking straight at the object through each side. Most drawings will be shown in three views, but occasionally you will see two-view drawings, particularly those of cylindrical objects.

A three-view orthographic projection drawing shows the front, top, and right sides of an object. Refer to figure 3-7, view C, and note the position of each of the six sides. If you eliminate the rear, bottom, and left sides, the drawing becomes a conventional 3-view drawing showing only the front, top, and right sides.

Study the arrangement of the three-view drawing in figure 3-8. The views are always in the positions shown. The front view is always the starting point and the other two views are projected from it. You may use any view as your front view as long as you place it in the lower-left position in the three-view. This front view was selected because it shows the most characteristic feature of the object, the notch.

The right side or end view is always projected to the right of the front view. Note that all horizontal outlines of the front view are extended horizontally to make up the side view. The top view is always projected directly above the front view and the vertical outlines of the front view are extended vertically to the top view.

After you study each view of the object, you can see it as it is shown in the center of figure 3-9. To clarify the three-view drawing further, think of the object as immovable (fig. 3-10), and visualize yourself moving around it. This will help you relate the blueprint views to the physical appearance of the object.

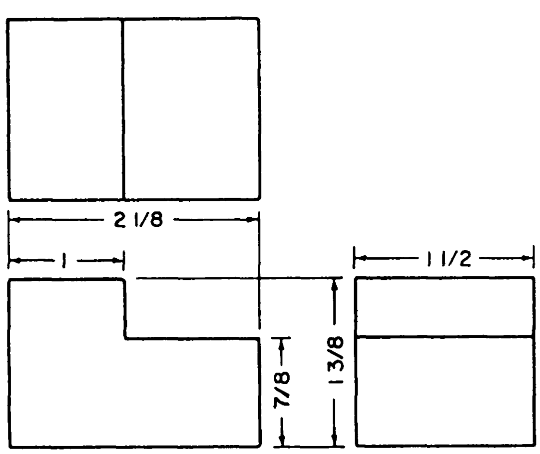

Figure 3-8.—A three-view orthographic projection.

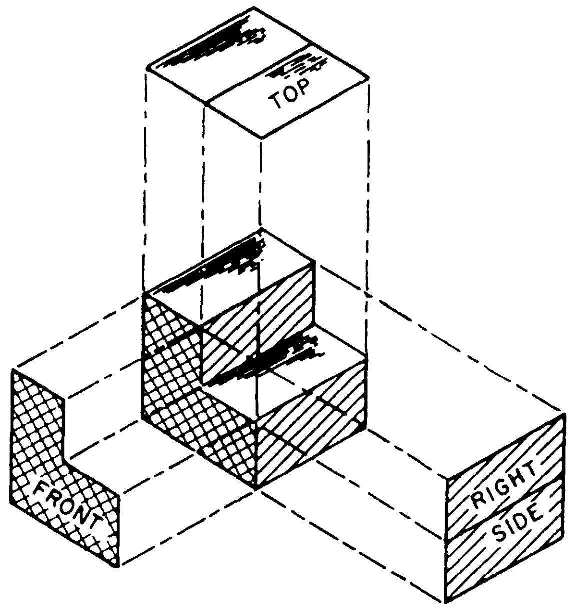

Figure 3-9.—Pull off the views.

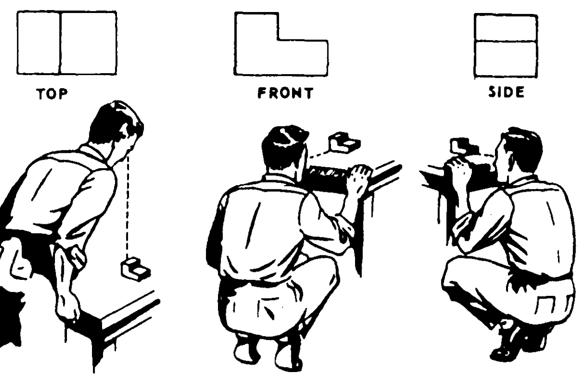

Figure 3-10.—Compare the orthographic views with the model.

Now study the three-view drawing shown in figure 3-11. It is similar to that shown in figure 3-8 with one exception; the object in figure 3-11 has a hole drilled in its notched portion. The hole is visible in the top view, but not in the front and side views. Therefore, hidden (dotted) lines are used in the front and side views to show the exact location of the walls of the hole.

The three-view drawing shown in figure 3-11 introduces two symbols that are not shown in figure 3-8 but are described in chapter 2. They are a hidden line that shows lines you normally can’t see on the object, and a center line that gives the location of the exact center of the drilled hole. The shape and size of the object are the same.

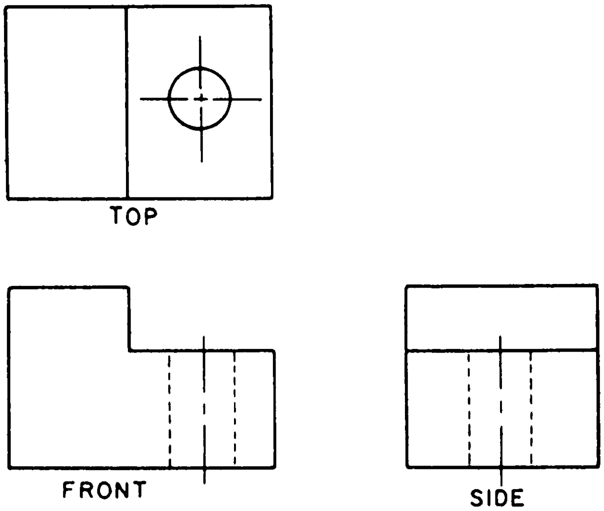

Figure 3-11.—A three-view drawing.

PERSPECTIVE DRAWINGS

A perspective drawing is the most used method of presentation used in technical illustrations in the commercial and architectural fields. The drawn objects appear proportionately smaller with distance, as they do when you look at the real object (fig. 3-12). It is difficult to draw, and since the drawings are drawn in diminishing proportion to the edges represented, they cannot be used to manufacture an object. Other views are used to make objects and we will discus them in the following paragraphs.

SPECIAL VIEWS

In many complex objects it is often difficult to show true size and shapes orthographically. Therefore, the draftsmen must use other views to give engineers and craftsmen a clear picture of the object to be constructed. Among these are a number of special views, some of which we will discuss in the following paragraphs.

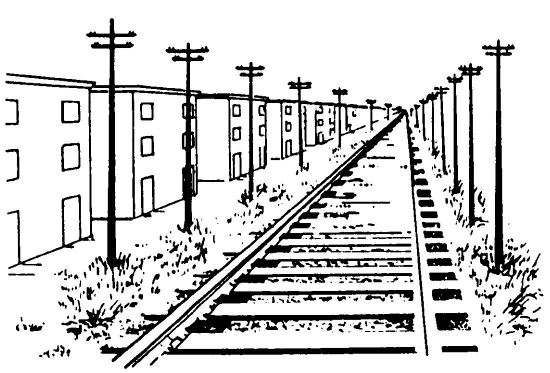
Figure 3-12.—The perspective.

Auxiliary Views

Auxiliary views are often necessary to show the true shape and length of inclined surfaces, or other features that are not parallel to the principal planes of projection.

Look directly at the front view of figure 3-13. Notice the inclined surface. Now look at the right side and top views. The inclined surface appears foreshortened, not its true shape or size. In this case, the draftsman will use an auxiliary view to show the true shape and size of the inclined face of the object. It is drawn by looking perpendicular to the inclined surface. Figure 3-14 shows the principle of the auxiliary view.

Look back to figure 3-10, which shows an immovable object being viewed from the front, top, and side. Find the three orthographic views, and compare them

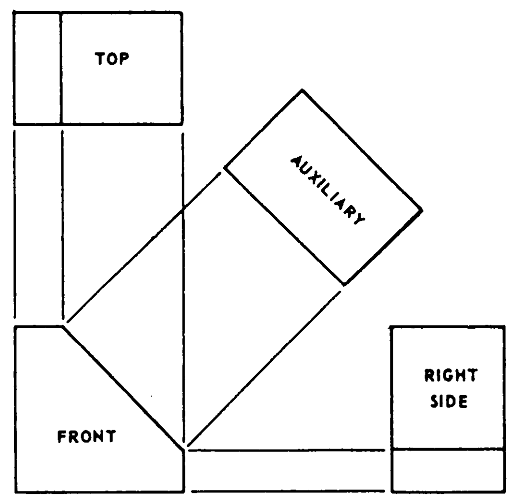

Figure 3-13.—Auxiliary view arrangement.

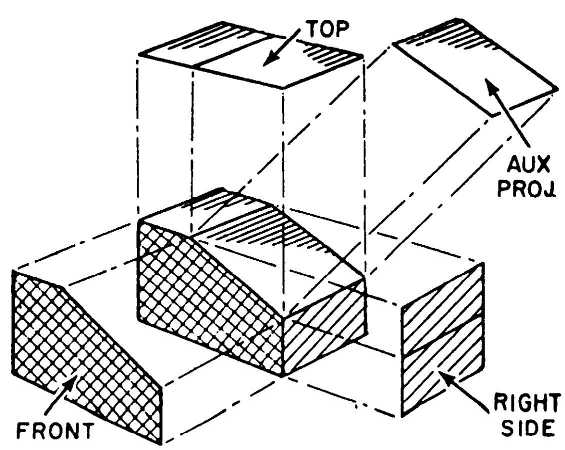

Figure 3-14.—Auxiliary projection principle.

with figure 3-15 together with the other information. It should clearly explain the reading of the auxiliary view. Figure 3-16 shows a side by side comparison of orthographic and auxiliary views. View A shows a foreshortened orthographic view of an inclined or slanted surface whose true size and shape are unclear. View B uses an auxiliary projection to show the true size and shape.

The projection of the auxiliary view is made by the observer moving around an immovable object, and the views are projected perpendicular to the lines of sight. Remember, the object has not been moved; only the position of the viewer has changed.

Section Views

Section views give a clearer view of the interior or hidden features of an object that you normally cannot see clearly in other views. A section view is made by visually cutting away a part of an object to show the shape and construction at the cutting plane.

Notice the cutting plane line AA in the front view shown in figure 3-17, view A. It shows where the imaginary cut has been made. In view B, the isometric view helps you visualize the cutting plane. The arrows point in the direction in which you are to look at the sectional view.

View C is another front view showing how the object would look if it were cut in half.

In view D, the orthographic section view of section A-A is placed on the drawing instead of the confusing front view in view A. Notice how much easier it is to read and understand.

When sectional views are drawn, the part that is cut by the cutting plane is marked with diagonal (or crosshatched), parallel section lines. When two or more parts are shown in one view, each part is sectioned or crosshatched with a different slant. Section views are necessary for a clear understanding of complicated parts. On simple drawings, a section view may serve the purpose of additional views.

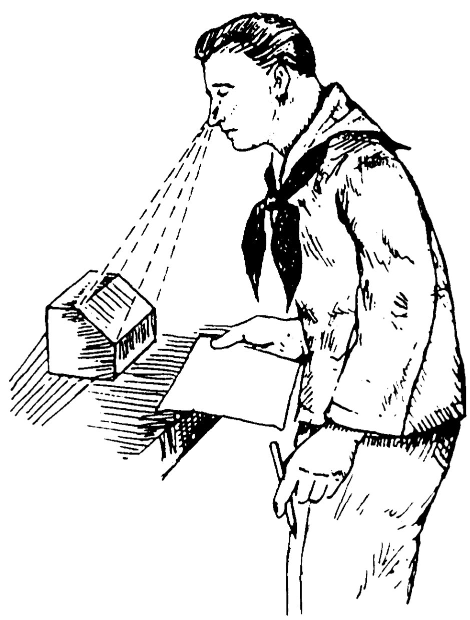

Figure 3-15.—Viewing an inclined surface, auxiliary view.

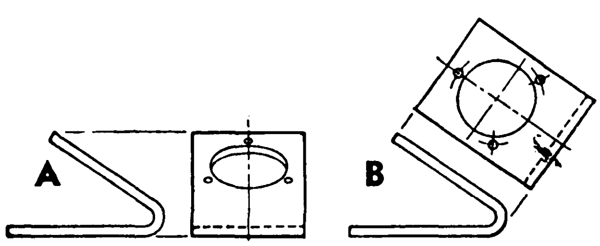

Figure 3-16.—Comparison of orthographic and auxiliary projections.

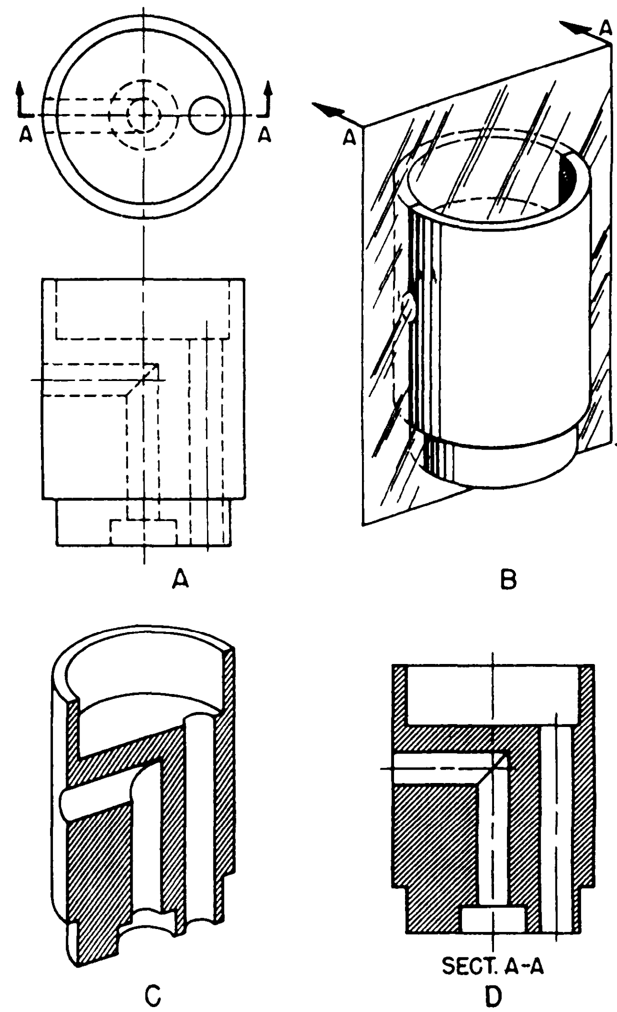

Figure 3-17.—Action of a cutting plane.

Section A-A in view D is known as a full section because the object is cut completely through.

OFFSET SECTION.—In this type of section, the cutting plane changes direction backward and forward (zig-zag) to pass through features that are important to show. The offset cutting plane in figure 3-18 is positioned so that the hole on the right side will be shown in section. The sectional view is the front view, and the top view shows the offset cutting plane line.

HALF SECTION.—This type of section is shown in figure 3-19. It is used when an object is symmetrical in both outside and inside details. One-half of the object is sectioned; the other half is shown as a standard view.

The object shown in figure 3-19 is cylindrical and cut into two equal parts. Those parts are then divided equally to give you four quarters. Now remove a quarter. This is what the cutting plane has done in the pictorial view; a quarter of the cylinder has been removed so you can look inside. If the cutting plane had extended along the diameter of the cylinder, you would have been looking at a full section. The cutting plane in this drawing extends the distance of the radius, or only half the distance of a full section, and is called a half section.

The arrow has been inserted to show your line of sight. What you see from that point is drawn as a half section in the orthographic view. The width of the orthographic view represents the diameter of the circle. One radius is shown as a half section, the other as an external view.

REVOLVED SECTION.—This type of section is used to eliminate the need to draw extra views of rolled shapes, ribs, and similar forms. It is really a drawing within a drawing, and it clearly describes the object's shape at a certain cross section. In figure 3-20, the draftsman has revolved the section view of the rib so you can look at it head on. Because of this revolving feature, this kind of section is called a revolved section.

REMOVED SECTION.—This type of section is used to illustrate particular parts of an object. It is drawn like the revolved section, except it is placed at one side to bring out important details (fig. 3-21). It is

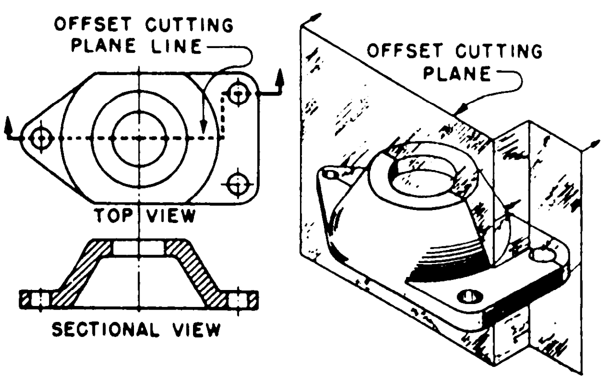

Figure 3-18.—Offset section.

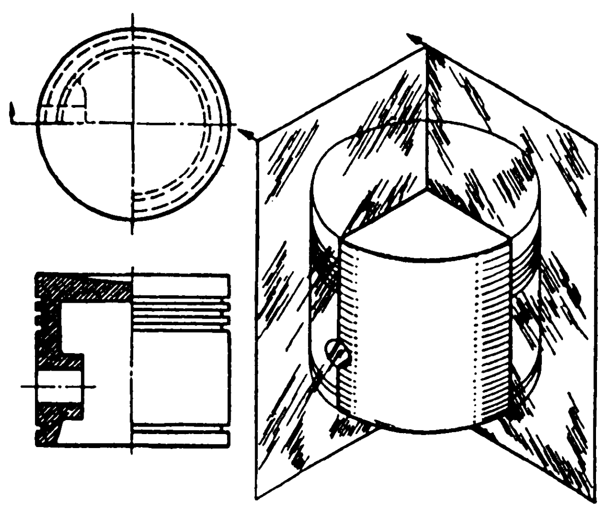

Figure 3-19.—Half section.

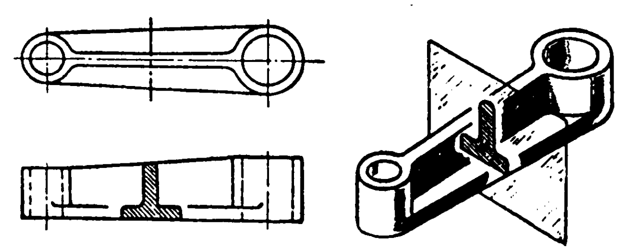

Figure 3-20.—Revolved section.

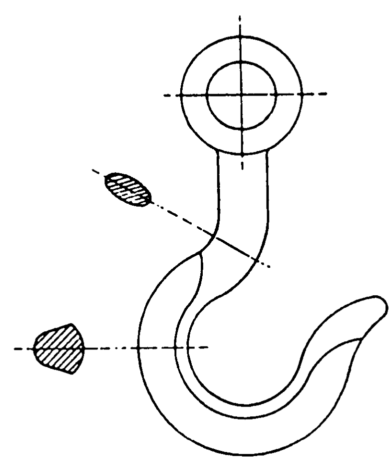

Figure 3-21.—Removed section.

often drawn to a larger scale than the view of the object from which it is removed.

BROKEN-OUT SECTION.—The inner structure of a small area may be shown by peeling back or removing the outside surface. The inside of a counterbored hole is better illustrated in figure 3-22 because of the broken-out section, which makes it possible for you to look inside.

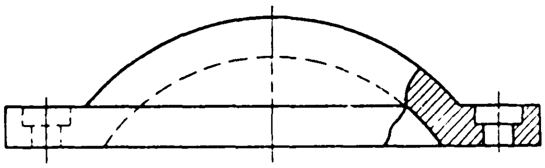

Figure 3-22.—Broken-out section through a counterbored hole.

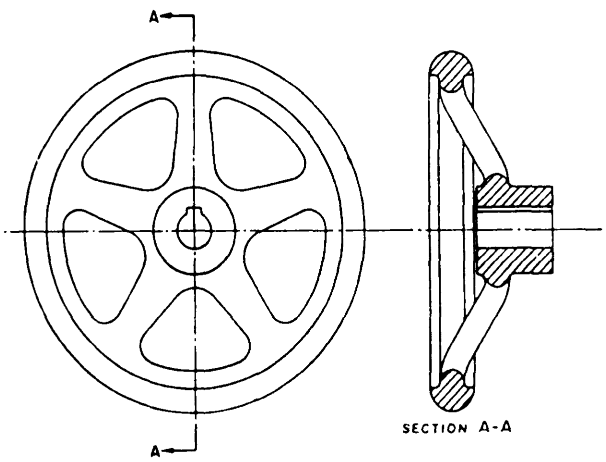

Figure 3-23.—Aligned section.

ALIGNED SECTION.—Figure 3-23 shows an aligned section. Look at the cutting-plane line AA on the front view of the handwheel. When a true sectional view might be misleading, parts such as ribs or spokes are drawn as if they are rotated into or out of the cutting plane. Notice that the spokes in section A-A are not sectioned. If they were, the first impression might be that the wheel had a solid web rather than spokes.

Exploded View

This is another type of view that is helpful and easy to read. The exploded view (fig. 3-24) is used to show the relative location of parts, and it is particularly helpful when you must assemble complex objects. Notice how parts are spaced out in line to show clearly each part's relationship to the other parts.

DETAIL DRAWINGS

A detail drawing is a print that shows a single component or part. It includes a complete and exact description of the part's shape and dimensions, and how it is made. A complete detail drawing will show in a direct and simple manner the shape, exact size, type of material, finish for each part, tolerance, necessary shop operations, number of parts required, and so forth. A detail drawing is not the same as a

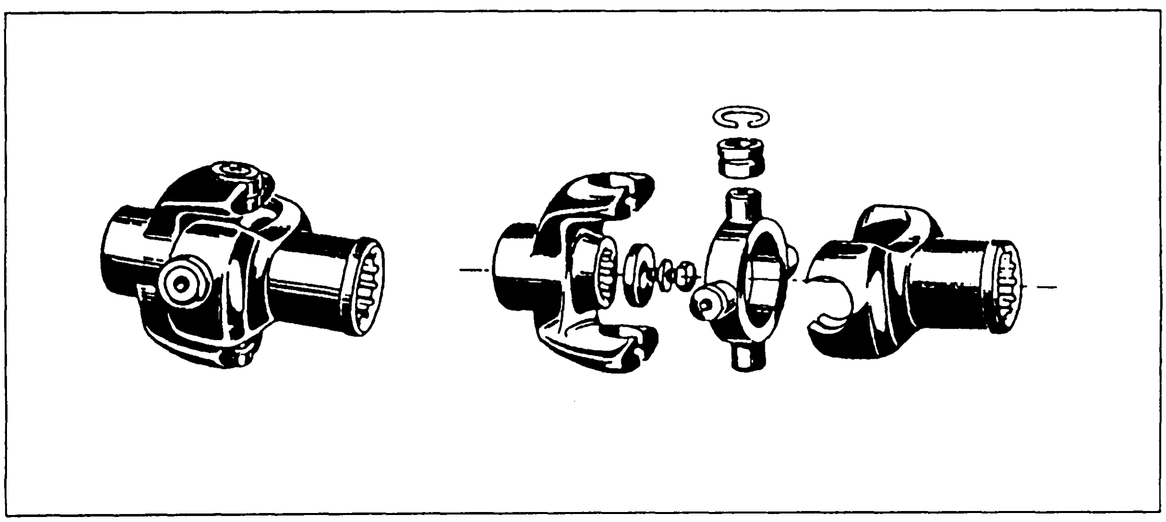

Figure 3-24.—An exploded view.

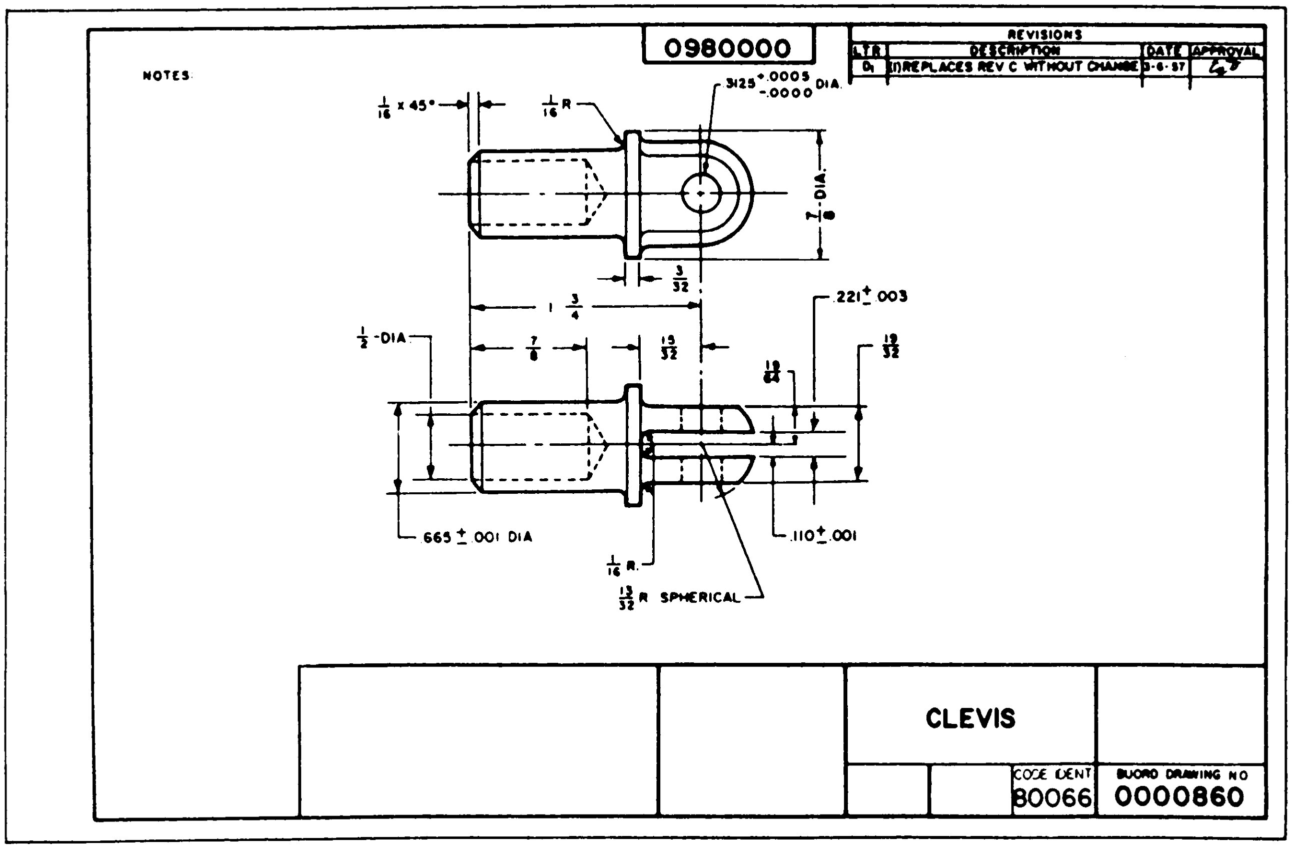

Figure 3-25.—Detailed drawing of a clevis.

detail view. A detail view shows part of a drawing in the same plane and in the same arrangement, but in greater detail to a larger scale than in the principal view.

Figure 3-25 shows a relatively simple detail drawing of a clevis. Study the figure closely and apply the principles for reading two-view orthographic drawings discussed earlier in this chapter. The dimensions on the detail drawing in figure 3-25 are conventional, except for the four toleranced dimensions given. In the top view, on the right end of the part, is a hole requiring a diameter of 0.3125 +0.0005, but no – (minus). This means that the diameter of the hole can be no less than 0.3125, but as large as 0.3130. In the bottom view, on the left end of the part, there is a diameter of 0.665 ±0.001. This means the diameter can be a minimum of 0.664, and a maximum of 0.666. The other two toleranced dimension given are at the left of the bottom view. Figure 3-26 is an isometric view of the clevis shown in figure 3-25.

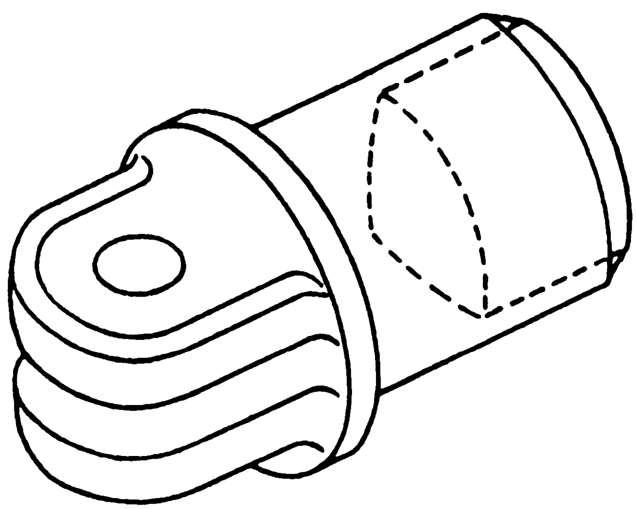

Figure 3-26.—Isometric drawing of a clevis.

Figure 3-27 is an isometric drawing of the base pivot shown orthographically in figure 3-28. You may think the drawing is complicated, but it really is not. It does, however, have more symbols and abbreviations than this book has shown you so far.

Various views and section drawings are often necessary in machine drawings because of complicated parts or components. It is almost impossible to read the multiple hidden lines necessary to show the object in a regular orthographic print. For this reason machine drawings have one more view that shows the interior of the object by cutting away a portion of the part. You can see this procedure in the upper portion of the view on the left of figure 3-28.

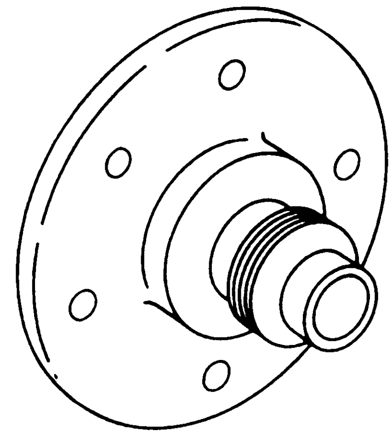

Figure 3-27.—Isometric drawing of a base pivot.

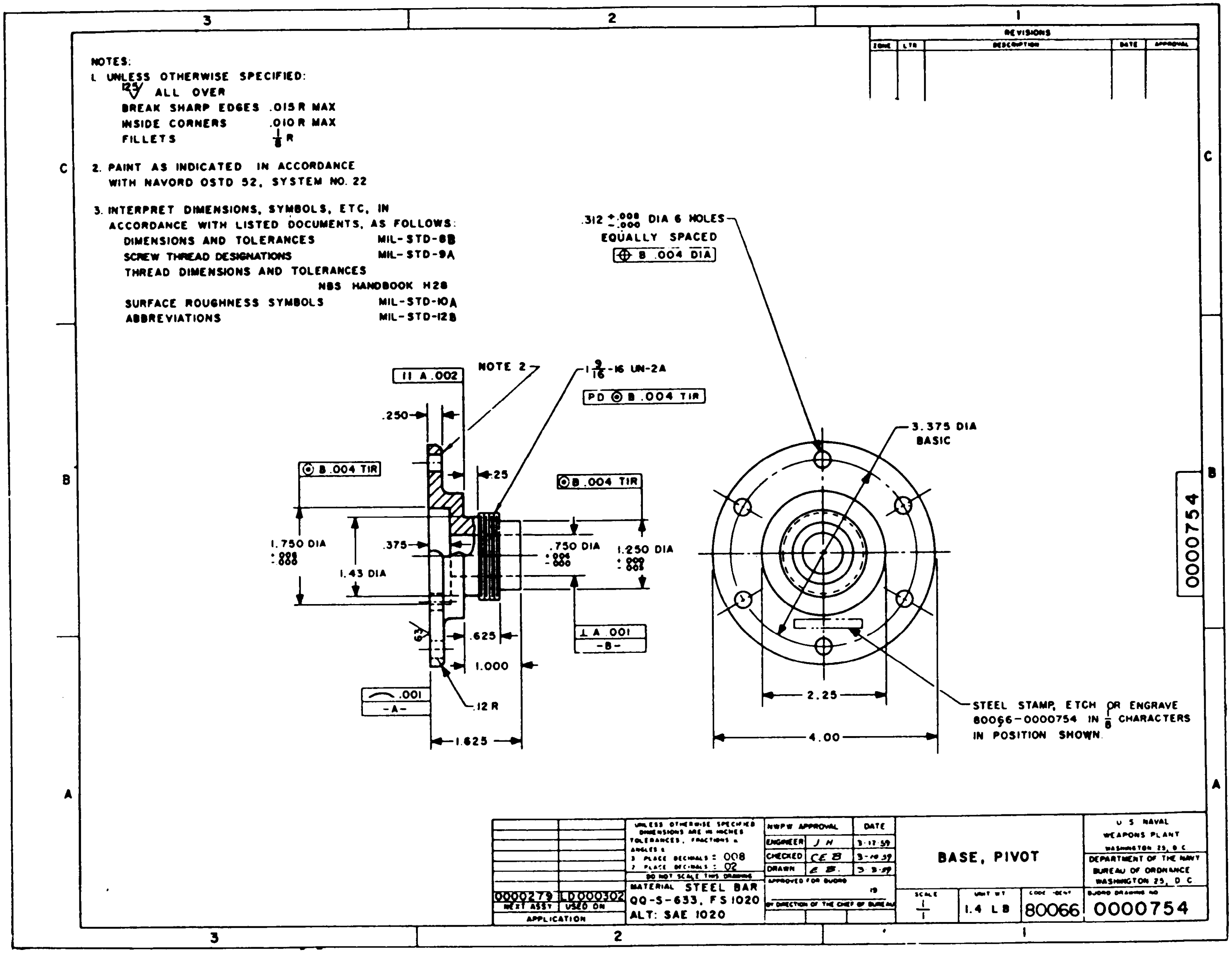

Figure 3-28.—Detail drawing of a base pivot.